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APPLICATIONS OF JOINT TACTICAL SIMULATION MODELING

by

Steve VanLandingham

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Thesis Advisor: Bard K. Mansager
Second Reader: Gordon H. McCormick

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Advances in technology allow Computer Simulation Models (CSM) to be used as a powerful tool to aid military decision makers. This thesis explores the usefulness of one of these models, the Joint Tactical Simulation (JTS). First, this thesis outlines the information and tasks required to run JTS, which will give the reader a basic understanding of the program and how much effort it requires. Next, it describes the scenario presented in this thesis by detailing the methodology of terrain development, listing the assets required and the mission concept employed. It concludes by discussing some of the advantages and disadvantages of JTS followed by a reevaluation of the simulation and its possible uses.

The concluding appendix is a tutorial that guides the reader through an amphibious assault modeled on the UNIX-based computer systems at the Naval Postgraduate School's (NPS) Secure Systems Technology Laboratory. It was designed to be accomplished in less than four hours and give the user an opportunity to run a simulation while conducting minimal interaction.

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APPLICATIONS OF JOINT TACTICAL SIMULATION MODELING

Steve VanLandingham
Lieutenant, United States Navy
B.S., United States Air Force Academy, 1992

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Author: ______________________
Steve VanLandingham

Approved by: ______________________
Bard K. Mansager, Thesis Advisor

____
Gordon H. McCormick, Second Reader

____
Maurice D. Weir
Chairman, Special Operations Curriculum Committee

ABSTRACT

Advances in technology allow Computer Simulation Models (CSM) to be used as a powerful tool to aid military decision makers. This thesis explores the usefulness of one of these models, the Joint Tactical Simulation (JTS). First, this thesis outlines the information and tasks required to run JTS, which will give the reader a basic understanding of the program and how much effort it requires. Next, it describes the scenario presented in this thesis by detailing the methodology of terrain development, listing the assets required and the mission concept employed. It concludes by discussing some of the advantages and disadvantages of JTS followed by a reevaluation of the simulation and its possible uses.

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I. INTRODUCTION

War gaming is not new to the military strategist, but what is new is the degree to which technological advances allow Computer Simulation Models (CSM) to be used as a powerful gaming tool. Today, high-resolution CSMs are so detailed they allow you to control the amount of time it takes individuals to reload their weapon, how much of a factor fatigue plays, and even the amount of contrast an individual's eyes are able to discern. However, one drawback to this is that the more detail used when modeling a situation, the more results will vary. Consequently, programs like Joint Tactical Simulation (JTS) allow the modeler to determine the degree of detail based on the type of analysis desired.

The process of modeling a military operation on a CSM requires decision-makers to approach the situation in a systematic fashion. First, they must determine their force structure and what assets they will require. Next, they have to input the capabilities of the enemy, a process that requires analysis of the opponent. Then decision-makers must program the routes their forces will take, an action that requires terrain analysis and orchestration of troop movement. Finally, running the simulation allows modelers to analyze the plan and determine if there are any critical nodes that need to be addressed. This step-by-step approach aids the planners by making sure they complete a thorough and comprehensive operational concept. However, it is important to understand that computer simulations do not take the place of decision-makers, but instead, CSMs give operational planners a powerful tool to aid in the decision-making process.

In order for these technological advances to be utilized in the Naval Special Warfare (NSW) community, it is important to first understand what would limit their implementation. The two biggest constraints in the NSW planning cycle are the limited time available to perform detailed mission planning and limited outside support. SEAL Platoons conduct most of their own planning as well as all of their gear preparation, which leaves little time to spare in the 96 hour planning cycle common to operational planning. If JTS is to be used in this situation, therefore, it must be with a streamlined or scaled-down procedure. On the other hand, in the longer deliberate planning cycle, as in developing new tactics, JTS would seem to have great potential.

The scenario presented in this thesis was designed to gain a quick familiarity with CSMs, more specifically JTS. Furthermore, JTS was chosen to illustrate its flexibility. This will be accomplished by depicting a wide variety of assets from fixed-wing to helicopters and from carriers to Amphibious Assault Vehicles (AAVs) as well as a number of different ground forces.

A. OBJECTIVES

There are two goals associated with this thesis: write a tutorial and investigate the usefulness of the Joint Tactical Simulation (JTS) CSM. The first and most important goal is to make JTS more useful in NSW planning by decreasing the amount of effort required to utilize the program. This will be accomplished by writing a tutorial that will allow an individual to get a brief, yet fairly detailed glimpse of the JTS capabilities. With this tutorial, an individual should be able to sit down at a computer workstation and, in less than 4 hours, obtain a good idea of JTS capabilities. This time should be shorter if an individual has a basic understanding of the UNIX or DOS operating environments, or previous experience with other CSMs.

The second goal of this thesis is to investigate the utility of this program and determine who would benefit from it. Ideally, with the aid of the tutorial, others will be inclined to evaluate the program for themselves or their commands. An ancillary goal is that increasing the awareness of the program should also increase user input to the programmers, which would generate a product better tailored to the needs of the end-user. Lastly, this scenario should depict a wide variety of assets, covering all services, which will demonstrate the flexibility of this system and lay the foundation for future analysis and development of more detailed missions.

B. RESEARCH AND DESIGN METHODOLOGY

The Joint Tactical Simulation (JTS) was chosen not only because it is in use at Special Operations Command (SOCOM), but also because it has recently been acquired by the Naval Postgraduate School (NPS). The best approach in learning the model furthermore has not been fully developed. The fact that this author is new to modeling will hopefully provide insights into the best method in optimizing one's time in learning how to use JTS.

This paper first uses JTS manuals to construct a basic understanding of what information and tasks are required to run JTS. This will give those persons unfamiliar with Combat Simulation Modeling or High Resolution Models (HRM) a chance to become somewhat familiar with the basic logic and databases that JTS uses. This will serve as an introduction for the tutorial and develop the outline for its use. Furthermore, it will bring to light some issues to pay particular attention to during the simulation.

Next, this paper will describe the timeline for the scenario used in conjunction with this thesis. This will list the defending Red Force's assets and capabilities and delineate the operational plan for the Blue Force's amphibious assault, by giving their force organization, list of assets, and planned routes.

Once the reader has a basic understanding of JTS and the scenario presented in the Appendix, this paper will discuss the advantages and disadvantages of this program followed by a reevaluation of its application. Finally, it will cover the possible future utility of this program as well as suggesting follow-on simulations.

The Appendix will guide the reader through a short simulation using JTS, highlighting points of interest. This section will require access to a JTS workstation and will be more beneficial if the reader has the scenario setup files that were constructed for this tutorial. The reader should also know where the system administrator has installed the files for the JTS program.

C. ORGANIZATION

This thesis will be divided into four chapters with one appendix. Following this Introduction, Chapter II briefly describes War Gaming and the role modeling plays. This will be followed by advantages and disadvantages of CSMs, closing with an introduction to JTS. Chapter III will detail the timeline and force structure for the scenario used in the Appendix. Chapter IV discusses possible uses of the JTS program, contains recommendations on the benefits and drawbacks of the system, and outlines possible scenarios that could be used to further investigate this program's usefulness. The Appendix will be a stand-alone tutorial for the JTS program; in conjunction with the already developed scenario, the reader should be able to use this tutorial to walk-through some of the basic JTS functions and have a fundamental understanding of the capability of this system.

II. JTS METHODOLOGY

The purpose of this chapter is to discuss the Joint Tactical Simulation (JTS) and the possible ways in which it can be used. First it will investigate the technique of Campaign Analysis (CA) and how it aids the decision-maker, followed by an outline of advantages and disadvantages of computer simulation models. Finally, it will detail the JTS model by discussing model inputs and outputs, with the processes required obtaining them.

A. CAMPAIGN ANALYSIS

Campaign Analysis is a technique for exploring military engagements that blends the art of war, strategic planning and tactical knowledge. This big-picture process can be divided into two categories: Force-on-Force and Predator-Prey. The scenario presented in the Appendix is a Force-on-Force analysis and reflects a multi-sided campaign with head-on-head confrontation. An example of the Predator-Prey model is Anti-Submarine Warfare (ASW) and exemplifies a "hunt". For illustrative purposes, this thesis will utilize the Force-on-Force type in order to outline Campaign Analysis and the role modeling plays. (Hughes, 1997)

War Gaming is a systematic, interactive process that allows a decision-maker to evaluate an engagement or campaign. First the inputs are selected, which include the number and capability of opposing forces as well as the scenario or model which will guide the analysis. Next the process for evaluating the interaction of the inputs is chosen; this is where a High Resolution Model (HRM) could be used. Once the inputs are processed, the results are analyzed to draw conclusions and adjust the inputs for further war gaming if required. (Hughes, 1997)

B. COMPUTER SIMULATION MODELS

One of the critical links in this process is the model used to process the inputs. HRMs are gaining in utility and popularity for this purpose. However, anyone using these computer simulations should realize that certain advantages and disadvantages are inherent with their use. On the positive side, the modeler is required to take a systematic approach to the problem, which ensures that all avenues of interest are addressed. As previously stated, the process of setting up the simulation requires development of friendly force structure and analysis of enemy capabilities. Furthermore, emerging computer technologies allow broader and more in-depth simulations to be conducted in a shorter period of time. This means that several different iterations can be conducted of the same scenario, followed by a sensitivity analysis that would let the decision-maker choose the most efficient way to allocate his forces.

Likewise, present military cost constraints require more cost-effective measures in order to investigate the usefulness of military hardware and tactics.

For instance, when procuring a technologically advanced piece of equipment, simulations can be run to determine what improvements would make it more beneficial to the troops using it. Moreover, HRMs make it possible to comprehensively examine proposed tactics, techniques and procedures before they are tested in the field, resulting in obvious cost savings. Finally, increased awareness of enemy capabilities affords the modeler detailed data regarding enemy hardware and tactics, which further increases the utility of these simulations in wargaming.

However, there are certain drawbacks that should also be addressed. First, the model is only as good and as accurate as the data for the input parameters. Bad data generally produces bad simulation results. Furthermore, the more detailed one tries to be, the more the sources of error increase with the possibility of producing great variations in the results. For example, if one is modeling the flip of a coin, it can be assumed that there is a 50 percent chance the coin will land on either a head or a tail. This probability will model the event rather accurately; however, in reality, this does not cover all possible outcomes: a coin could fall down the gutter or land in the dirt on its edge, resulting in neither a head or a tail. Although these events are not out of the question, including them in the discussion can be unnecessarily cumbersome. This relates to the possibility of complicating a simulation by trying to use too much detail.

Another negative aspect to using computer simulation models is, that using them might not be practical depending upon how much time is available. One factor that is critical for this consideration is the size of the database that contains the various weapon systems used during the simulation. If a unit is conducting Crisis Action Planning in response to a time critical event, then time is of the essence and developing a number of new weapon systems for the database could be impractical due to time constraints. Likewise, there might be only enough time to conduct a minimal analysis resulting in limited utility when time might have been spent more efficiently.

Finally, it is important to reiterate that interactive HRMs are not intended to replace the decision-maker, but instead be a tool to aid the decision-maker. Moreover, HRMs are not supposed to take the man out of the loop and run a completely automated battle, but rather to highlight possible critical nodes, which should be addressed with further analysis.

C. JOINT TACTICAL SIMULATION MODEL

JTS is an interactive, multi-sided, entity-level simulation system consisting of eight components which include: the terrain editor, scenario editor, symbol editor, Probability of Hit/ Probability of Kill (PH/PK) editor, JTS simulation/ Graphical User Interface (GUI), data converter, analyst workstation, and JTS reports (The JTS Scenario Manual, 1997). Furthermore, it uses stochastic as opposed to deterministic algorithms, which means that a random element or variable is used to determine the outcome of events. The parameters that are used for these calculations make up an extensive database and its initial development is one of the main time constraints for using this system. The following is a more in-depth look into the make-up of the JTS model.

1. Terrain Editor

The terrain editor allows the user to create a notional terrain file or edit an existing digital terrain file from a number of different sources, which contain actual geographic data. Once a file has been initialized, it is possible to create or modify terrain features such as vegetation, roads, rivers, lakes, buildings, fences or virtually any type of feature one can conceptualize. The elevation and vegetation data contained in these files is used for Line-of-Sight (LOS) and cover/ concealment calculations during the running of the simulation. This is potentially one of the choke points in using this system, and if a terrain file requires much modification, it should be addressed early in the modeling process. (The JTS Terrain Editor Manual, 1997)

2. Scenario Editor

Like the terrain data, the scenario data must be completed before the simulation can be run. This editor allows the user to create, modify and review force characteristic data, force organization data, model parameter data, and setup data. (The JTS Scenario Manual, 1997)

First, the force characteristic data deal with the capabilities of each of the combat systems to be used in the model. The basic parameters include the system's weapon, munitions, and sensor. For example, if the modeler was developing a rifleman in a platoon, he could indicate that this individual carried an M-16 with 5.56-mm ball ammunition and that his sensor was his unaided eye (as opposed to field glasses, a thermal imager, etc.). Or if he was developing a self-propelled howitzer, he could indicate that it had a 155-mm cannon, high explosive rounds and a thermal imager. Depending on the degree of detail desired, the weapon system capabilities can become very descriptive.

This editor also allows the modeler to input the force organizational data. This encompasses the force's Chain-of-Command for up to seven different sides allowing as varied forces as desired. This is the section that delineates the number of combat systems in each task force.

Model parameter data include a number of variables that could be grouped into the "fog and friction of war" category. Clausewitz developed this notion to describe any uncertainty that hinders a commander's ability to make an informed decision. JTS addresses this concept by including the effects of weather and illumination upon a scenario. It also describes the effects of fatigue on the troops and its ability to hinder performance. In addition, fratricide and how well the troops are able to identify their own forces is also represented.

Finally, the setup data indicate which files are to be used for a simulation run. In addition to the previously mentioned information, the model needs to have scenario-specific information such as the initial location of troops, and what routes they will be using. Additionally, this file assigns specific forces to a JTS workstation. Only one force can be managed from a workstation, but multiple workstations can be used to control a force.

3. Symbol Editor

The symbol editor is an interactive program, which allows the user to develop symbols representing various forces on the Graphical User Interface (GUI) during the running of the simulation. Some symbols are already created and can be accessed in the Public database. The user can create his own symbol for equipment or forces that are not represented. (The JTS Symbol Editor Manual, 1997)

4. Probability of Hit/Probability of Kill (PH/PK) Editor

PH and PK data represent the effectiveness of weapons expressed as probabilities that a hit will kill various targets at various ranges. There is a startup database which is an extensive database that lists the effectiveness of every weapon modeled in the simulation against every possible target of the scenario, to include friendly forces. (The JTS PH/PK Editor Manual, 1997)

5. JTS Simulation / Graphical User Interface (GUI)

There are four possible modes to run the simulation: interactively with an unplanned Scenario, interactively with a planned scenario, Batch mode, and Play back mode (The JTS Simulation Manual, 1997). The first mode is beneficial when the user only wants to define the available forces, but not positions or routes. This mode allows the user to run the simulation a number of different times, easily testing different movements or tactics.

The next mode is interactive with a planned scenario in the form of a Planning file or Breakpoint file. The Planning file is used when the positions and routes of friendly forces have already been determined, and the goal is to run the same scenario repeatedly. The breakpoint file is useful for chopping up a simulation run and running sections at a time in order to evaluate different options. It operates by periodically saving all relevant data in order to recreate the present simulation conditions, which is also useful for system/ power failures. Batch mode runs the simulation as fast as possible without user interactions. This is useful for running a certain scenario a number of times in order to do a sensitivity analysis on the resulting data. The last mode is Play back, which lets the user replay a saved simulation run.

6. Data Converter

JTS uses a series of stochastic algorithms to convert the input data and the user interactions from the GUI into analyzable data. Initially created to "provide a realistic, stress filled, simulated urban combat training environment", JTS provides "high resolution treatment of time, space, weapons capabilities and effects, battlefield environment and their interaction with the combat process" (The JTS Algorithms Manual, 1997, p. 7). Although historically, CSMs have been used to simulate ground combat and the interaction with air assets, the detailed requirements of JTS make it possible to model a number of different situations such as the maritime environment. This ability could become especially useful for the Naval Special Warfare community.

7. Analyst Workstation

The Analyst Workstation (AWS) generates near real time reports of the simulation data for a segment of time or for the complete simulation run. With a pull down menu, the user can access engagement statistics such as sensor acquisitions, force movement, and the results of direct fire engagements, which permit a detailed analysis of the events. This information is viewed in graphical form with reference to elapsed time, and displays concluding statistics. Another option is to replay the simulation on the GUI, allowing a visual analysis of force performance. (The JTS Analyst Workstation Manual, 1997).

8. JTS Reports

During the simulation, it is possible to acquire reports dealing with the forces in the simulation. This allows the user to isolate a particular force and determine the system identification and its Chain-of-Command relationship. Furthermore, it reports a system's movement, posture, altitude, remaining energy or fuel, and which opposing forces can be seen. Lastly, a report can be produced showing the number and type of opposing systems killed and how many systems are remaining in a friendly Task Force, including their ammunition and supply status.

E. CONCLUSIONS

From this brief look at the amount of knowledge and expertise required to run JTS, using JTS can seem like a daunting task. However, once the programmer has passed the initial pain of learning the system, the program's utility for mission planning becomes almost limitless. Although some possible uses of JTS have been listed, they are not an exhaustive compilation, and only serve to further illustrate the model's potential for operational planning.

III. JTS SCENARIO DEVELOPMENT

In order to run a simulation, JTS requires a certain number of databases, which outline weapon systems and their capabilities, chain of command relationship, terrain, movement orders, and the interaction of all forces involved in the scenario. These files can either be created from scratch or existing files can be modified with the use of the four editor programs: Scenario editor, Symbol editor, Probability of Hit/Probability of Kill (PH/PK) editor, and Terrain editor. Weapon systems that are not in the archived files can usually be modeled by using a military reference book or the Internet. Likewise, proposed weapon systems can be entered into the scenario to test their effectiveness or to do a sensitivity analysis on the advantages of different modifications. In the scenario presented in this thesis, most of the weapons systems were already archived except for a few such as the Land Craft, Air Cushion (LCAC), but by using the Internet to access Jane's Fighting Ships, the relevant parameters were easily acquired. Likewise, the symbol editor was used to create the corresponding symbol, and for those with no artistic ability, the Commander-in-Chief Pacific Command (CINCPAC) has a web page with federal clip art, which facilitates generating new symbols.

In general, most of the information required to run a simulation in JTS will be archived except possibly the digital terrain file. Therefore, this chapter will begin by discussing how the terrain was developed for the scenario presented in the Appendix, which will help to illuminate the flexibility of JTS when modeling the environment. Next, this chapter will focus on the force structure and timeline for the amphibious assault in this same scenario, giving the reader an appreciation for some of the possible uses of JTS.

A. TERRAIN

As stated earlier, one of the basic requirements to run JTS is a digital terrain file. The terrain used in this thesis is a Digital Terrain Elevation Data (DTED) file of Camp Pendleton in Southern California. The information was downloaded from the National Imagery and Mapping Agency (NIMA) over the Internet, and then was easily modified into JTS format. The database used to procure this file almost covered the entire world in varying degrees of detail, which attests to the flexibility inherent to this computer simulation model. However, this file only had elevation information, and hence it was necessary to modify the file to represent the area being modeled with respect to vegetation, lakes, rivers, and physical structures. Although this extra work seems like a disadvantage at first, it allows the user to have more control and flexibility over representing these changing terrain conditions. The modeler can also determine the size of the area and the detail of the topography. In this case, a 70-kilometer (km) by 70 km area was used with a 150 meter (m) contour interval. The following sections will describe how this terrain file was modified, and how it can be modified to model various environmental conditions.

1. Lakes

One of the terrain features that JTS allows one to model is lakes or large bodies of water. Seven different types of bodies of water can be detailed for any simulation; however, this scenario only required one, the Pacific Ocean. Each body of water has an attributes index, which requires the user to input the relative degradation of speed for various systems, either equipment or personnel. This speed factor is a percentage of the system's maximum water or fording speed and takes into account the depth and turbulence of the water. This means that each system has a speed it can travel in water, depending upon whether it can touch the bottom, hence a modeler can use this variable to account for different sea states. Sea states are of great importance in planning NSW missions. In this case, the ocean was modeled with a negligible sea state so only watercraft could navigate within it. Although it was not used in this case, an additional body of water could be placed adjacent to the shoreline to model the different effects of the surf zone on various systems, to include landing craft or swimmers.

2. Vegetation

JTS also allows you to model seven different types of vegetation, which can be placed throughout the terrain map, for any simulation. Like the lake feature, the vegetation feature has a speed degradation factor for the various weapon systems, but it also allows the modeler to determine the foliage height and hence the degree to which a system can use it for concealment or defilade. Vegetation also effects visibility, which in turn effects sensor performance and a weapon's ability to shoot. For this simulation, the first type of vegetation was placed at the mouth of the two rivers to simulate moderately dense scrub brush and foliage that grows next to constant water sources. Another type was used along the shoreline to simulate a beach with limited concealment and the resistance effects of sand on vehicle tractability.

3. Rivers

Rivers were also used in this simulation, and similar to the previous two features, are divided into seven different categories. JTS uses the water depth, current and fording speed discussed earlier to determine the effects of the river on a system attempting to cross it. In this scenario, the northern river was detailed as seven meters wide, one meter deep, and with a one-half knot current. Likewise, the southern river's attributes were a width of 15 meters, a depth of two meters, and a current of one and a half knots. These rivers are not readily noticeable on the initial display except for the vegetation near the point where they enter the ocean. However, the Graphical User Interface (GUI) allows the user to zoom in for a more detailed view and the rivers become more discernable.

4. Buildings

The final terrain feature used in this simulation was the building feature, which allows the user to develop urban areas with up to 99 different buildings. Although the scenario presented in the Appendix has only a few buildings to represent Camp Pulgas, great detail can be achieved when modeling structures. The user can model buildings made of a variety of material, from wood to concrete, and with up to 20 floors, each with a different room layout. Furthermore, the precise position of windows and doors can be detailed. This capability was of minimal importance for the scenario presented in this thesis, and the author chose to stick to the basics, omitting intricate detail on urban developments. However, the extensive application to urban combat or Close Quarters Battle (CQB) should be evident.

B. FORCE STRUCTURE AND TIMELINE

Although JTS is capable of modeling seven different sides with a hostile, friendly or neutral disposition to each other, only two sides were used in this research: Red and Blue. Camp Pendleton is defended by the Red forces, which are based at Camp Pulgas overlooking the ocean. In order to protect this base they have a layered defense that consists of ground and anti-aircraft forces. The ground defense is led by four BTR-60s positioned near the beach, which are supported by three 152mm self-propelled howitzers located near the camp. The middle layer is three T-72 tanks positioned between the beach and the camp. Red's air defense consists of two SA-13s and two ZSU 23-4s based near the camp, as well as five RPG-16 and two AT-4 teams positioned throughout the area of operations. Prior to Blue's amphibious assault, Red forces are conducting patrolling operations in the objective area. This is shown in Figure 1.

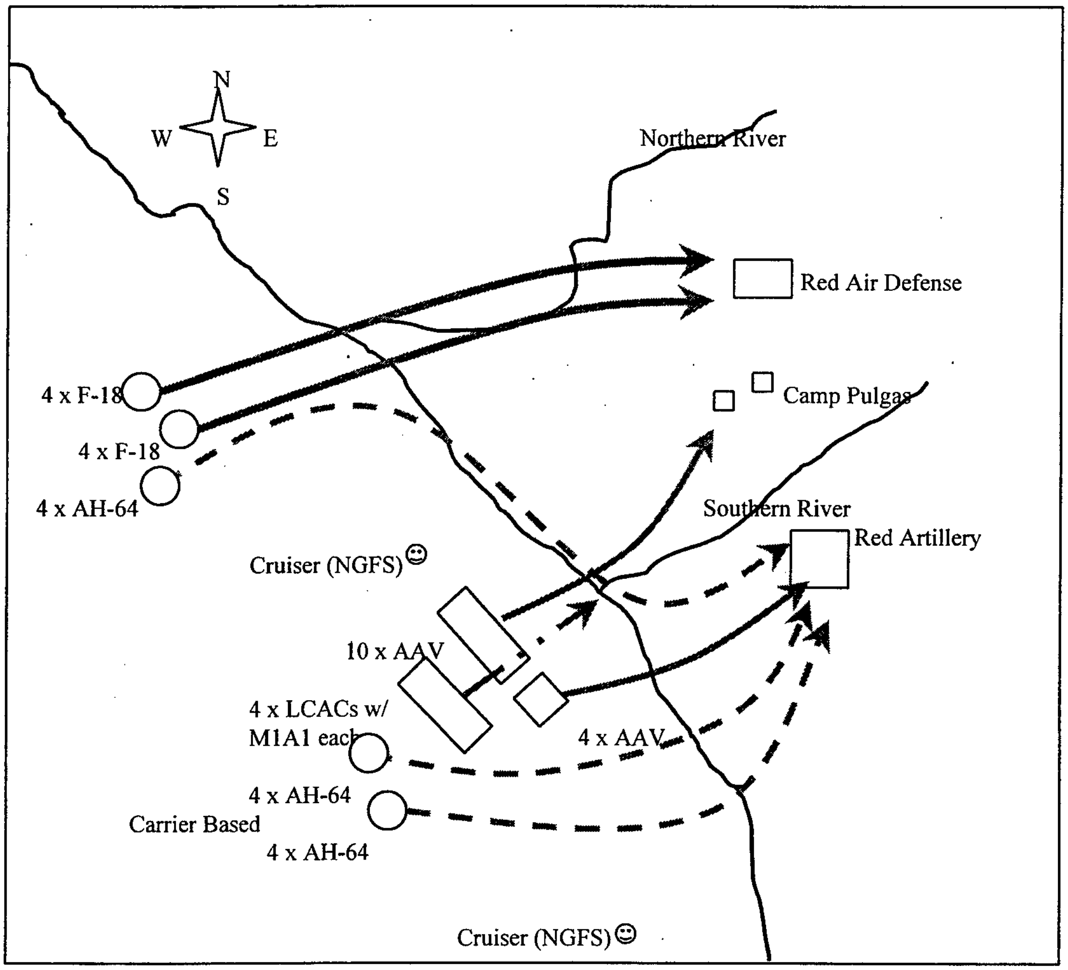


Figure 1. Operation "Strike"

During the first ten minutes of the assault, Red forces spot Blue's amphibious assault and move into a hasty defense. The amphibious landing begins when two cruisers positioned off the coast direct Naval Gunfire Support (NGFS) onto the beach landing site (BLS) in order to suppress Red activity. Next, eight AH-64 helicopters follow the southern river to Camp Pulgas in order to neutralize Red artillery directed at Blue's BLS. At this same time, six F-18s use the northern river to approach Red's encampment.

From the 11^{th} to the 20^{th} minute, Blue F-18s, launched from an aircraft carrier off the coast, attack Red air defense assets near Camp Pulgas. Additionally, Blue NGFS shifts to the Camp Pulgas area as 14 Amphibious Assault Vehicles (AAVs) begin the landing during which time they are firing at enemy positions overlooking the beach.

For the next 10 minutes, Blue AAVs secure the BLS for the subsequent LCAC landing. Once Blue's four LCACs land, each unloads one M1 tank and returns to the open ocean. Next, four more AH-64s join the original gunship contingent to support the Blue advance up the canyon to Camp Pulgas. During these maneuvers, one squad of AAVs moves to the high ground overlooking the canyon to monitor the assault.

The time remaining in the simulation is spent observing Blue's movement to the Camp Pulgas objective. Once Blue forces arrive at the camp, they exchange fire with the remaining Red forces, which are effectively suppressed.

C. SUMMARY

As stated earlier, the purpose of this scenario is to provide the user with a basic understanding of JTS and to show its flexibility. The reader should not judge the operation based solely on its practicality, but should note the variety of assets employed by both Blue and Red forces. Additionally, there will be some variance in the timeline for each run of the simulation. For the scenario presented in this thesis, however, the times should remain fairly constant. Finally, most of the information required to execute this simulation was already archived or could be generated from modifying the archived data. It was surprisingly simple to find missing information from the Internet and enter it into the program files, such as the desired digital terrain file from the extensive database at NIMA. The learning curve is very steep for the user to develop the initial simulation, but once completed, the process can be readily duplicated.

IV. CONCLUSIONS

Advances in computer technology make it impossible to neglect Computer Simulation Models (CSM) as a tool to benefit mission planning. The question is not whether CSMs can they aid decision making, but how they can be used most effectively. The following concluding chapter addresses this issue by discussing advantages and disadvantages of JTS, and ends by suggesting follow-on simulations to further investigate the future utility of this system. It is important to note that the author has drawn his conclusions after using the JTS Version 1.2.2 as configured in the Naval Postgraduate School's (NPS) Secure Systems Technology Lab (SSTL).

A. ANALYSIS

One of the main disadvantages to JTS, inherent to any computer program, is the breadth of its configuration files. A modeler may not want to use every capability or function of the system, but it is important to be familiar with them all. This author spent a considerable amount of time finding out that NPS's version of JTS can not effectively run an interactive simulation in the as-fast-as-possible time mode. After hours of consternation, a toggle in the setup files enabled the program to run smoothly, an action that would have been instinctive to someone with more experience with the system.

This highlights the next drawback of JTS, which is that running a simulation in the as-fast-as-possible time mode is inefficient. It is nearly impossible to interact with the program in this mode, even for something as simple as obtaining reports from weapon systems in the scenario. This time mode is designed to allow a user to run a number of repetitive simulations in order to do an analysis on the resulting information. Without player interaction, a scenario can be run reasonably fast. Viewing the simulation as it develops, however, is not very informative.

Another concern to using JTS is that many of the parameters input into the program are from extensive databases and it is taken on faith that they are accurate. This is not to say that these files would be purposely skewed, however they could be mistakenly altered. This would prompt one to have a personal familiarity with this information in order to trust it, which would lead to database management and a dedicated person to oversee this concern.

The final JTS drawback that is also inherent in many computer programs is the amount of time it takes to become familiar with the system. A lot of problems are caused from inexperience. Until the user gets a solid foundation with the program, many needless errors will be committed. Although some of this knowledge is transferable, there is still a considerable amount that must be learned through hands-on practice or one-on-one instruction.

However, once the modeler becomes familiar with JTS, many of the operations are academic. The initial difficulty of learning how to run the system becomes an exercise in fine-tuning the parameters for the most accurate analysis. Furthermore, if the weapon systems are already modeled to the user's satisfaction, testing a number of different scenarios for the same operation becomes a simple task. Similarly, once the user knows where to find information on weapon systems and digital terrain files, entering them into the system is relatively easy.

B. RECOMMENDED FUTURE ANALYSIS

As stated earlier, the purpose of this thesis was to write a basic tutorial for JTS and investigate its usefulness. The scenario presented in the Appendix represents a general military operation with a focus on modeling a variety of systems. It does not address JTS's efficiency, unit tactics, or weapon capabilities.

One of the first studies that should be conducted is a sensitivity analysis on the different parameters and algorithms of JTS and how they effect its efficiency. This would benefit further analysis by determining the limits of the system's capabilities and which parameters have the most impact on the program. With this knowledge, modelers would be able to set up a scenario within the reasonable limits of the system instead of finding out that they have overburdened it after inputting all the information.

Another possible JTS investigation could be exploring unit tactics. Not only could this be performed in a general sense, but it could also be used on terrain specific areas. This would help a unit adjust their tactics to meet the demands of a particular location and environment. A direct application of this would be modeling a search operation to find the most proficient means to probe an actual location to find enemy weapon systems or missing personnel.

Likewise, JTS could be used to help predetermine certain courses of action for a sixteen-man SEAL platoon before they went into the field. It could be used to determine the best way for the platoon to prosecute the objective, which would be another terrain/location specific application. Likewise, a target could be completely reconstructed with vegetation and sensors, and the best avenue of approach found. If the mission is Special Reconnaissance, the platoon could find the best position to monitor the target. Furthermore, it could be used to model a building or ship in order for a platoon to gain a familiarity with the structure before actually conducting an exercise on it. Finally, JTS's potential to model the ocean environment should be pursued. One use would be to find the best beach landing site due to sea state, terrain and enemy intelligence assets. Another utilization could be comparing the performance of different watercraft for different ocean profiles on the same mission. This environment must be utilized if JTS is to be of use to NSW units.

C. CONCLUSIONS

The possible application of CSMs appears to be limitless. Although they might not be the single answer to solving difficult decisions regarding operational analysis, they definitely have the potential to be beneficial for certain functions. Not only does JTS provide a cost-effective means to test tactics and equipment before using them in the field, but it also affords the user a mechanism to interactively examine the area of interest before actually deploying. Likewise, it affords a decision-maker a time-and-material efficient way to analyze an operation and to try different courses of action before employing them. The JTS model appears to have great utility for use within the NSW community.

APPENDIX. JTS TUTORIAL

A. INTRODUCTION

The purpose of this tutorial is to provide the reader a basic understanding of the capabilities of Joint Tactical Simulation (JTS) computer program. The tutorial was developed at the Naval Postgraduate School (NPS) Secure Systems Technology Laboratory (STL) and designed to be used with that version of JTS, 1.2.2, and a specific scenario. Although not all computer systems with JTS are configured in the same manner, most of this overview should be universal.

B. JOINT TACTICAL SIMULATION (JTS) OVERVIEW

JTS is an interactive multi-sided, entity level simulation system capable of modeling seven different sides in combat action. Each side can have a friendly, hostile or neutral disposition to the others and can be controlled through the Graphical User Interface (GUI). This gives the user a view of the terrain and the performance of their force, which are represented by predetermined symbols. However, a workstation can control only one side at a time or has the option to view the simulation from a universal perspective with limited interaction as the senior controller.

C. TUTORIAL OVERVIEW

This tutorial will begin by describing how to initialize a JTS simulation on the workstation located at NPS. Next it will present "Operation Strike", the scenario developed with this tutorial, by first giving an overview and then allowing the user to interact during the simulation, which will cover some of the basic elements required for developing a scenario. It will close by describing how to end the simulation and shut down the workstation.

D. COMMANDS

Most of the user interface for running the simulation in JTS is performed with the mouse, and the following terminology are the most commonly used functions:

"left click"	- position the mouse pointer in the desired location and click the left mouse button
"select"	- same as "left click"
"center click"	- same as "left click", but use the center mouse button
"right click"	- same as the previous two, but use the right mouse button
"double click"	- press the appropriate mouse button twice rapidly

“drag” - selecting an object while keeping the mouse button pressed and moving the mouse in order to move the selected object.

For those users unfamiliar with the UNIX system, the following is a helpful list of tools and commands:

Tools:

Window - indicates the tool used for typing commands into the system. A window is acquired by positioning the mouse pointer in a section of the screen with no applications, right clicking, selecting “Programs” by right clicking on it, and then selecting “Terminal…”. To begin typing in a terminal window, it is first necessary to “left click” anywhere within the window to select it.

Scroll bar - located on the right-hand side of the window. By positioning the mouse pointer on it and holding down a “left click”, it is possible to move the bar and view parts of the window that are not shown on the screen.

Copy and paste - copy a line of text and paste it at a prompt. This is accomplished by positioning the mouse pointer at the beginning of the line you want to copy, hold down a “left click” and drag the pointer until the text you want to copy is highlighted and release the left click. Next, position the pointer where you want to enter the text and “center click”.

Control^c - indicates pressing the control and c keys at the same time. This should be accomplished whenever the user is trying to get a prompt in a window that is not responding. It will terminate any program the window is running.

“Minimize the Window” - This is accomplished by selecting the dot in the upper right-hand corner of the window. The window will become a small icon located on the left of the computer screen.

“Open an Icon” - This is done with a “double click” on the appropriate icon

UNIX is case sensitive meaning that commands must be typed in the correct upper or lower case.

<cr> - carriage return, indicates pressing the enter key.

pwd - Print Working Directory, shows the user their position in the directory hierarchy.

ls - list, lists the current directory files.

cd <directory name> - change directory to <directory name>

E. LOGGING ONTO THE COMPUTER

The following sections will outline how to perform certain operations in the UNIX environment. Commands that are to be typed will be annotated with boldface print.

If the computer is currently ready for Global Command and Control System (GCCS), it is first necessary to reconfigure the system for JTS. This is accomplished by:

Logging into GCCS

1) Position mouse pointer in "GCCS Workstation" window and "left click"
2) Type user name next to "Login:" and press enter
3) Type user password next to "Password:" and press enter
4) Select "System" on the Tool Bar in the upper left-hand corner of the screen and then select "Power Down"
5) In the "SESSION MANAGER" window select "OK"
6) At the o.k. prompt (o.k.) type "**boot disk3**"
7) The computer should be reconfigured for JTS.

If the computer is already configured for JTS:

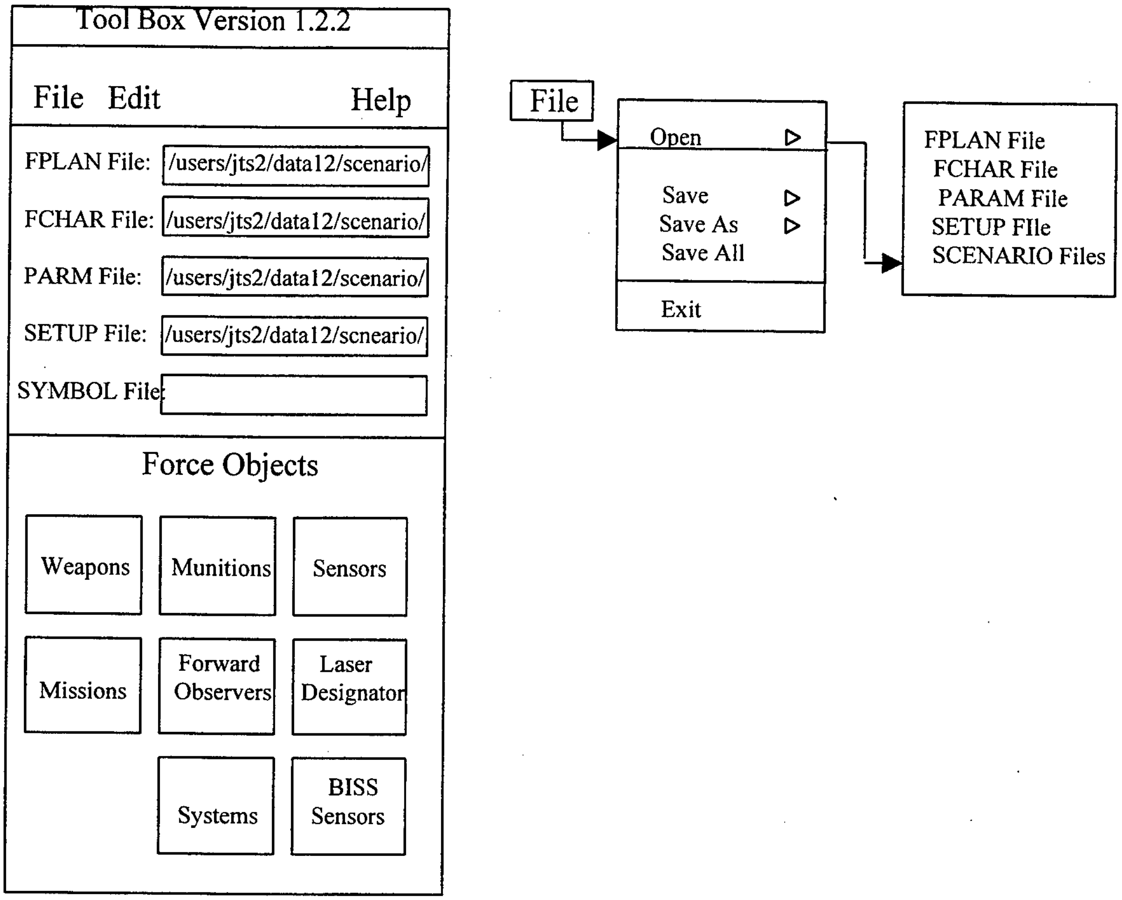
1) Select the "Welcome to elmer" window
2) Under "Please enter your user name" enter user name and press enter
3) In the "Welcome" window next to the prompt type your password. and press enter
4) When the system is ready, the screen should display a Tool Bar at the bottom and have two windows already opened. JTS uses three windows, so open a third as discussed earlier.

F. SIMULATION PERSPECTIVE

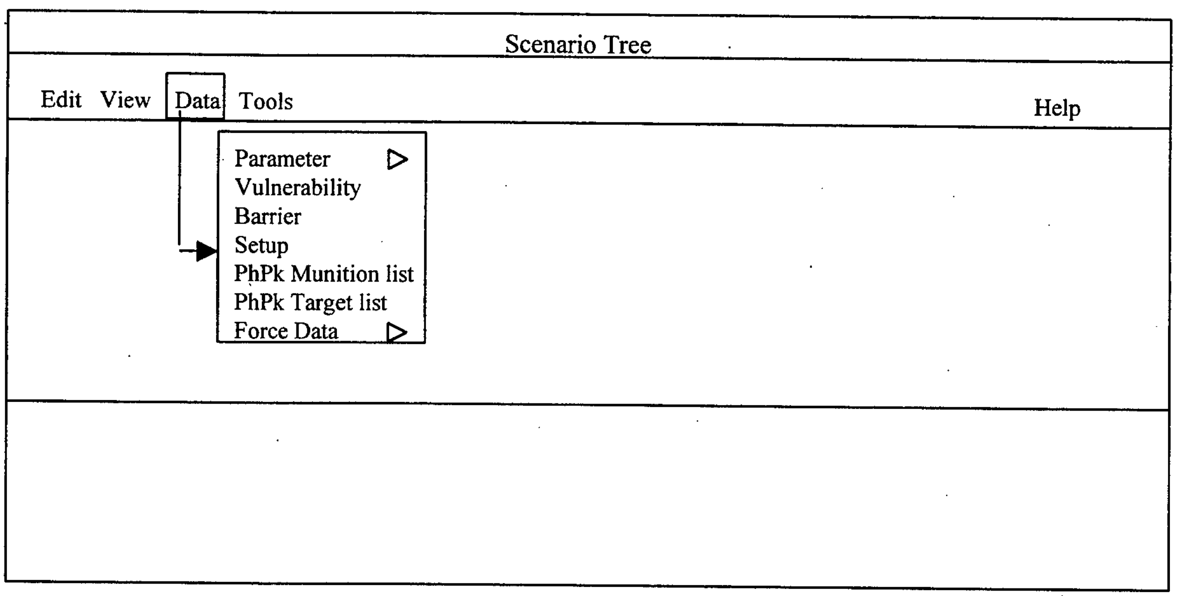
As stated earlier, each workstation can only control one side or have limited control as the Senior controller. For this tutorial, the user will first overview the simulation as the Senior controller and then modify the scenario as the Red Force commander. As the Senior controller, the user will be able to see all forces, however, as the Red Force commander, there will be limited intelligence, and only the blue forces that are visible to the red forces appear on the screen. Therefore it is necessary to ensure that the simulation is setup correctly. This must be done before any of the steps in the next section are accomplished or JTS will not recognize the newly configured files.

Workstation Setup

1) Select a window
2) Type "**vista**" and press enter, the scenario editor will be enabled
3) On the Tool Box window (see below) to the left of the screen select "File"
4) Next select "Open", and then select "scenario files"
5) A window listing available files will appear to the right of the screen. Ensure that the "Private" directory is selected and then select the "strike.setup" file.
6) Once the appropriate file is chosen, select "o.k."
7) On the "Scenario Tree" window select "Data", and then select "setup" (see below)
8) The "Workstation Assignments" section of the "Setup Editor" should be visible. Ensure that the "WS name" (workstation name) "elmer" is typed next to the Force name "control" and "none" is the workstation name for the remaining forces.
9) Select "apply changes" at the top of the window
10) Select "file" in the Tool Box window, and then select "Save all"
11) Finally select "file", then "exit"



“Tool Box” window



“Scenario Tree” window

The scenario editor should be closed, and the system should be configured to run the simulation as the Senior controller.

G. INITIALIZING JTS SIMULATION

The following section describes how to setup the system to run the simulation. This will require three terminal windows, which are easier to manage if they are spread out and not on top of each other. In order to move the windows around the screen, select the top of the window and drag it to the desired position.

JTS Initialization

1) In the first window change the directory to the one containing the scenario files. This should look like:

   cd data12/scenario <cr>

2) Next, ready the files for the simulation by typing:

   jtssim_rpc -f filename.setup <cr> (where **filename.setup** stands for the appropriate scenario filename. In this case it should be **strike.setup**)

   When the window displays "number of systems found = 65", proceed to the next step.

3) Now, in a new window, start the five button simulation window by typing:

   simButton <cr>

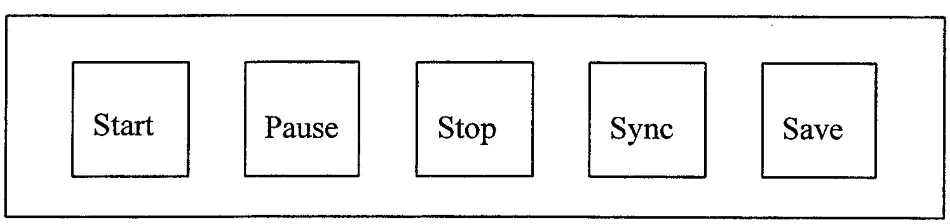
   A five-button window should appear

4) In the third window, change the directory as in step one of this section. Then, enable the GUI by typing:

   disMsgServer –f strike.setup (or the appropriate scenario filename)

H. BUTTON BOX

This section details how to start, pause, stop, synchronize, and save the simulation.



"Button Box" window

1. Start – this will start the game clock or restart it after a pause.
   a) Minimize the GUI by selecting the dot in the upper right corner.

   b) Select "Start" on the Button Box.

   c) In the first window created for initializing JTS, the line:
      "Enter planning file name, . to skip:"
      should appear.

   d) Select the window to get a blinking prompt.

   e) Enter a period and press return (". <cr>")

   f) Maximize the GUI icon by "double clicking" on it.

Once this is accomplished the game clock will start. However, it is possible that the setup files do not initiate the conflict. If no movement is detected, check the movement nodes of the systems in the simulation. This will explain if the systems' routes need to be planned, or if their movement nodes need to be turned on. This is detailed in the USER INTERACTION section under Routes.

2. Pause – This will pause the simulation game clock.
   a) Minimize the GUI.

   b) Select "Pause" on the Button Box.

3. Stop – this will end the simulation and close the GUI and the Button Box. In order to regain control of the windows after exiting the simulation, select the windows and use the control^c function.
   a) Minimize the GUI.

   b) Select "Stop" on the Button Box.

4. Save – this will save the current positions and states of the forces in the simulation. This is done to save the initial scenario planning file or save the simulation at a point the user desires to return.
   a) Minimize the GUI.

   b) Select "Save" on the Button Box

   c) In the first window created for initializing JTS, the line:

   d) "Enter planning file name, . to skip:"

   e) should appear.

   f) Select the window to get a blinking prompt.

   g) Enter the filename to save the plan and press "Enter". This filename should have the extension "fplan", and should be entered into the setup files discussed in Initializing JTS. For this scenario, the filename is "strike.fplan".

5. Sync – this will toggle the game clock between "real time" and "as-fast-as-possible" modes. This author was unable to run a scenario using as-fast-as-possible and still maintain reasonable control of the system functions.

   a) Minimize the GUI.

   b) Select "Sync" on the Button Box.

I. COMMON TOOL BAR

On the left-hand side of the GUI is a common tool bar with certain functions that will be helpful while viewing the simulation or planning a scenario.

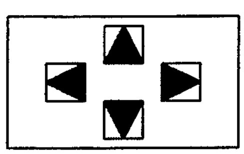
1. 

   Zoom – Select this to change the scale of the terrain map. This is done by selecting the zoom button, then positioning the pointer at one corner of the area of interest and "left click". Next position the pointer at the opposite corner of the area to be magnified and left click.

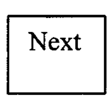
2. 

   Previous – Select this to see the previous displays that were used. JTS stacks zooms and pans remembering up to 25 since the last Overview.

Note: There is a pan tool located above the Player Menu on the right-hand side of the screen. Selecting one of the arrows moves a zoomed picture in the respective direction.



Pan Tool

3. 

   Next – Select this to see the next display in the stack. This is the opposite direction of the "Prev" function.

4. 

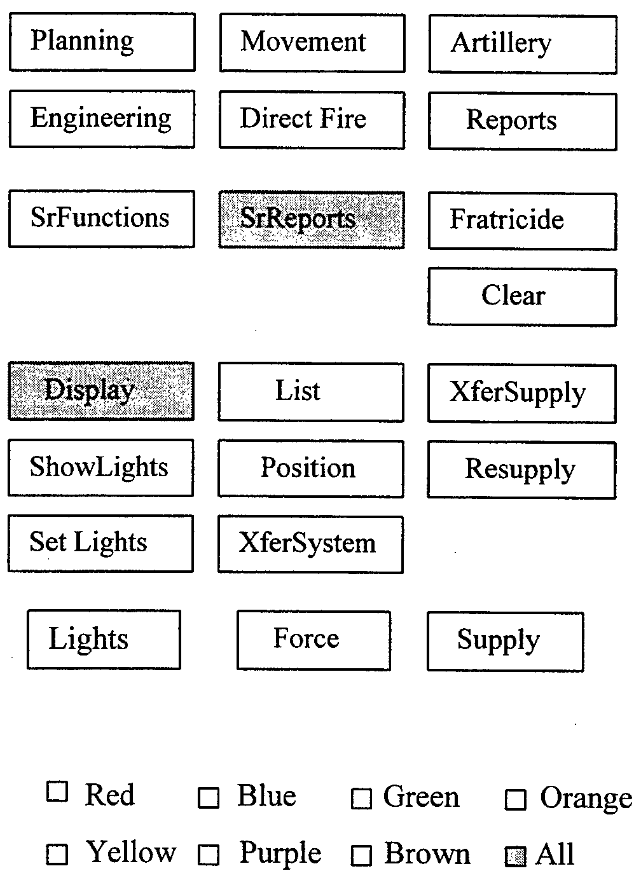
   Overview – The button with the globe depicted in the center returns the terrain map to the original image.

J. OPERATION "STRIKE"

This section details how to run the simulation that was developed to accompany this tutorial. It gives the scenario's approximate timeline and details actions for the user to get a familiarization with the system. It requires the user to initialize JTS as the Senior controller and start the simulation as discussed earlier. The Terrain Map shows a 70km by 70km area surrounding Camp Pendleton in southern California.

<u>Situation</u>: Red is conducting patrolling operations in the vicinity of Camp Pulgas, which is situated near in the hills overlooking the beach. Air defense forces are in a layered defense, beginning at the beach and ending in the hills northeast of Camp Pulgas. Red artillery is positioned in the hills to the southeast of Camp Pulgas. The Blue assault moves within 6 kilometers of the beach.

Once the simulation is initialized and started, use the Choice menu on the right of the screen to display all the forces in the scenario. This is accomplished by selecting "Senior Reports", "Display", and "All" (see below).



Senior Reports menu

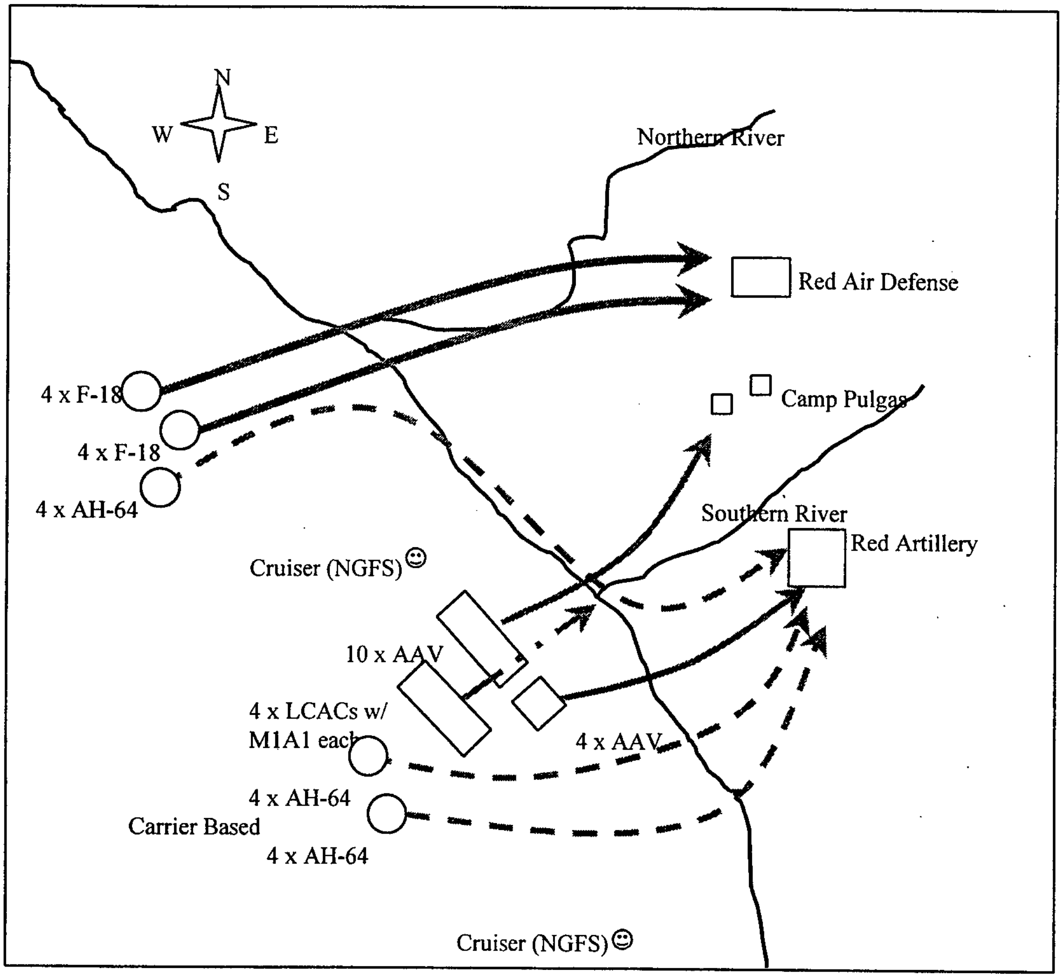
All the forces in the simulation should be displayed as the following scenario unfolds.

0 – 10 Minutes: The Red force observes the amphibious assault and moves into hasty defensive positions while calling for artillery support. The Blue force uses Naval Gunfire Support (NGFS) to suppress enemy activity on the hills overlooking the Beach Landing Site (BLS). AH-64 helicopters approach Camp Pulgas along the southern river, while F-18s approach the camp along the northern river. Red air-defense forces observe and fire on the Blue air assets. The helicopters engage Red artillery in order to neutralize their effectiveness on the forthcoming amphibious assault.

11 – 20 Minutes: Blue fixed wing aircraft engage Red air-defense forces to the northeast of Camp Pulgas. The AAVs begin their assault onto the beach, firing at enemy positions overlooking the beach. NGFS shifts from the beach to the Camp Pulgas objective area.

21 – 30 Minutes: Red forces hold their positions although incurring heavy losses. The AAVs maneuver across Red Beach and secure an area for the following LCACs to land. The LCACs land, each unloads an M1 tank and then all return to the open ocean. The gunships join with the attack force on the beach and together continue to attack into the canyon toward Camp Pulgas. A squad of AAVs moves into an over-watch position in the high ground to the south of the canyon.

31 – 50 Minutes: Blue and Red forces located in the objective area begin to exchange fire. The Blue force begins its final assault on the objective.



Operation "Strike"

J. USER INTERACTION

Once the user has seen the simulation in order to gain insight into the force interactions and movements of both sides, it is time to begin practicing scenario planning. If the user observed "Operation Strike", it was probably evident that the red forces were stationary. Therefore, the next step is to plan some basic actions for the red forces in order to try and repel Blue's assault.

The first step is to insure that the system is configured to control the appropriate forces. This is done as described earlier in the SIMULATION PERSPECTIVE section, except that instead of entering "elmer", the workstation name in the case of the NPS STL, by the Force name "control", it should be entered by "Red1".

Initialize the GUI as described earlier, but before starting the simulation, the force plan file needs to be altered. Once the terrain map is displayed, the Red forces should be visible. Camp Pulgas is just to the north of the southern river, and recognizable by the brown building shells. The air defense assets are located to the northeast of the camp, artillery is located to the south, and the remaining forces should be positioned on the beach where the amphibious assault takes place. Now, the user is ready to follow the basic steps to scenario development.

1. <u>Pre-deployment Locations</u>. When the user initializes a new scenario, the icons of the systems defined in the setup files will appear in a line along the bottom of the Terrain Map display. For "Operation Strike", the systems should already be in planned locations, however, they can be repositioned using the Planning Menu. On the right-hand side of the GUI, select "Planning" and then "position"

Planning	Movement	Artillery
Engineering	Direct Fire	Reports
SrFunctions	SrReports	Fratricide
		Clear
LOS	Surrender	Capture
Position	Show	Resupply
Xfer	Set	Xfer
red	Shoot	Fuel
	On	Confirm

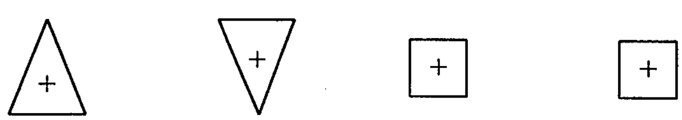
Planning menu

Now, once a system is selected, a yellow rubber band will be connected from the selected system to the mouse pointer. In order to reposition the system, choose a location to move the system and select it. If the system is placed in a position that is not possible (i.e. a truck on a lake), the system will return to its previous position. For "Operation Strike" position the tanks at the mouth of the southern river where the amphibious landing takes place in order to offer blue forces more resistance. The tanks have the letters “T-72” written on their side.

Another important aspect of planning is Line of Site (LOS) orientation. A moving system’s LOS will be straight ahead, but unless a stationary system has been modified, its LOS will be to the right of the screen. In order to check this, select the “Planning” menu as before, but now select the “LOS” button. Next, select a system, and its LOS fan will be drawn with a dotted white line in its direction of view and solid white lines for its periphery view. In order to modify any of these, select the line to be altered and a yellow rubber band will appear. Next select the new direction to position the line. By selecting a system with the center button, the LOS fan will be drawn with orange lines indicating the unobstructed view of the system. The user should ensure that all systems are oriented properly for the assault. If the screen becomes cluttered with LOS fans, select the “clear” button, and it will clear the screen without losing any of the planning information.

2. Routes. After all the systems have been placed in the desired location, the next step is to plan routes for systems that will be moving. First select the “Movement” menu and then select “extend” to enable this function. (see below)

Once these buttons are selected, the system is ready to plan routes. First, select a force symbol on the screen and the system’s planned route will appear. If the system’s movement order has not been planned, then only the node on top of the system will appear. The graphics used to signify the different movement states are listed below.



00:00 Activity

Go Node Stop Node Timed node Activity Node

Graphic display of speed drawn on top of node:

Fast Slow

Graphic display of Altitude or Posture drawn below node:

High altitude Or standing	Low altitude or crouching	Landed or prone

Planning	Movement	Artillery
Engineering	Direct Fire	Reports
SrFunctions	SrReports	Fratricide
		Clear

Show	Extend	Delete
Modify	ModifyNod	Copy
Mount	Mount	Load Bomb
Dismount	DismountCrew	
Start	Stop	

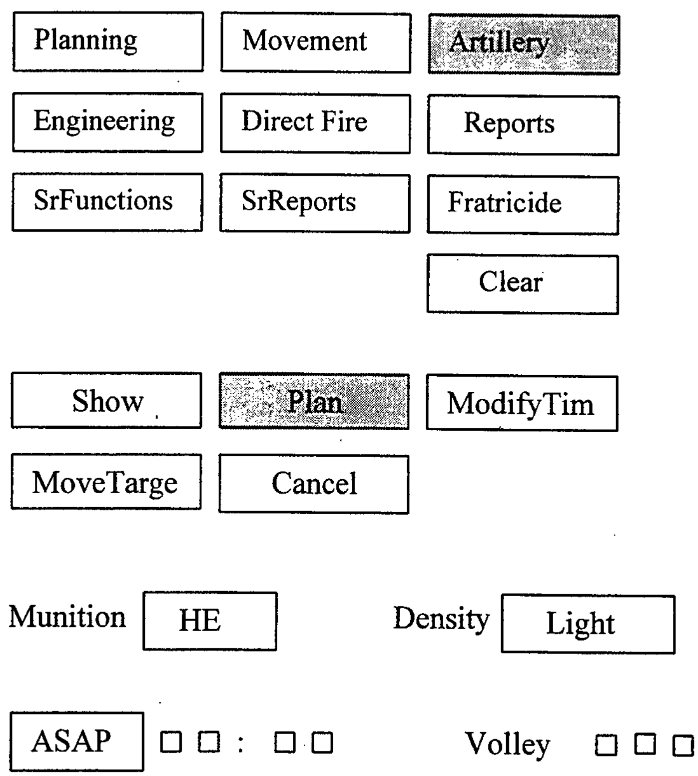
go	stand/high	route
BombType	fast	enter FP

Time: ☐ ☐ : ☐ ☐

Movement menu

Once the system is selected, select the node that is to be extended, and a yellow rubber band will connect itself from the node to the mouse pointer. Now select the next location you want the system to transit through, after the selected node, and a movement node will be place there. When this function is enabled, a right click will end the route planning for that system. Now the user should plan routes for the BTR-60s to patrol along the beach at blue's beach landing site, the mouth of the southern river. If the screen becomes cluttered with movement routes, select the "clear" button and it will clear the screen without losing any planning information.

3. Artillery. The next step the user should perform is to plan indirect fire missions for the 152mm Self-propelled howitzers located to the south of Camp Pulgas. The first step is to select the "Artillery" menu and the "plan" button (see below).



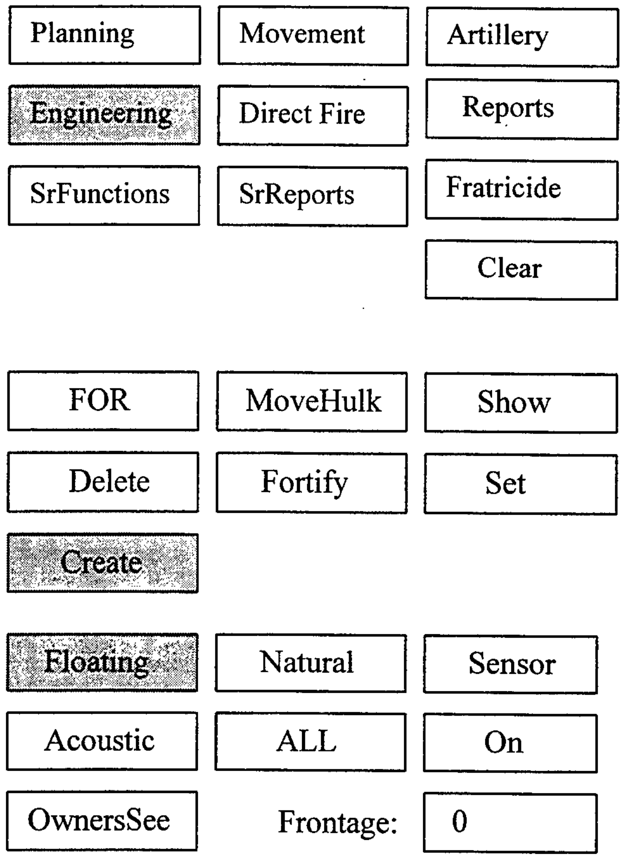
Artillery menu

Once these two buttons are selected, ensure that the HE (High-explosive) munition is selected by clicking on the appropriate button and selecting HE from the list that appears. Density refers to the number of rounds to be fired per volley: light is five rounds, medium is ten rounds and heavy is 15 rounds. The button works the same as the munition button, but for now select light. It is possible to plan artillery missions during the actual simulation; however, blue AAVs hit the beach around the tenth minute of the simulation so the user should plan a timed mission. Select the "ASAP" button and then select “timed”. Now, set the time on the adjacent clock. The first two digits indicate hours and the second two indicate minutes (HH:MM), so the time should read 00:10. The clock numbers are changed by selecting the desired button, and then selecting from the list of possible one digit numbers that appears. Also ensure that only one (001) volley is selected for now.

Now that the mission parameters have been entered, it is time to plan the mission. For “Operation Strike”, determine a line along the beach for the artillery pieces to fire upon. Now, use the mouse pointer to select the two endpoints of this line and a white line should be drawn between them. Once the second point is selected, a white star and minimum/maximum range rings will appear on each system capable of conducting the mission. Select the system(s) you want to conduct the mission profile, and a white line will be drawn from them to the impact line.

4. Engineering. The final planning action for the user to complete before running the simulation again, is to position barriers in the water to hinder the advance of Blue’s AAVs. The first step is to select the “Engineering” menu and then select the “create” button (see below).

If another function is annotated on the “floating” button, select the button and a list will appear with the word “floating”, which can then be selected. The Frontage field on the menu should show the amount of material that can be used. This amount and the width of the barrier are specified in the Force Characteristics File; for “Operation Strike”, the frontage should be 3 meters wide and 500 meters long. On the Terrain Map, select the two endpoints of the desired barrier, and a magenta rectangle representing the barrier should be drawn to the screen. The remaining frontage will be displayed on the menu. If there is not enough material to make the selected barrier, it will be shortened to the available length.



Engineering Menu

5. Saving the Plan. Once the scenario planning is complete, the user should save the plan as directed in the BUTTON BOX section under the filename "strike.fplan".

6. Running the Simulation. Now that the scenario has been planned, start the simulation as detailed in the BUTTON BOX section.

K. LOGGING OFF

In order to log off, find a clear space on the original screen and "right click". Next, select "Log out…", and when the "Log out Confirmation " window appears, select "OK"

L. CONCLUSIONS

After completing this tutorial, the reader should have a basic understanding of the capabilities of JTS and be able to conduct a simple scenario. Although this tutorial covers the actual running of a simulation, not all of the material was covered in depth. If there are any questions, refer to the JTS 1.2.2 manuals for a more detailed explanation.

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Rm. C287, Bldg 3915
Ft. Bragg, NC 28307-5000

16. Commander 1
Naval Special Warfare Center
NAB Coronado
San Diego, CA 92155

17. USS COM / SO - J7C 1
ATTN: Joel Parker
7701 Tampa Point Blvd.
McDill AFB, FL 33621-5323

18. US Special Operations Command 1
ATTN: Command Historian
McDill AFB, FL 33608-6001

19. Steve VanLandingham 2
104 Tanglewood
Starkville, MS 39750